

# SCIENCE

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ILLUSTRATED.

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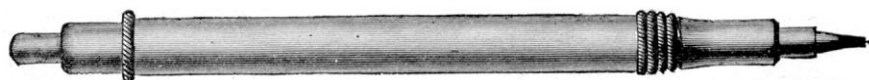
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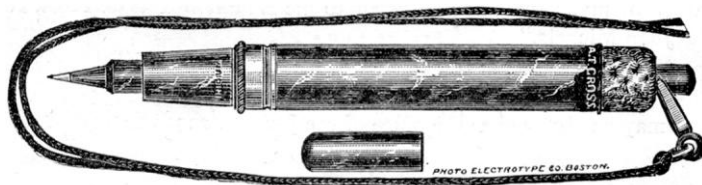
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## To Correspondents.

All communications should be addressed to the Editor—box 3838, P. O., New York—with name and address of writer, not necessarily for publication without consent.

Scientific papers and correspondence intended for publication should be written *legibly* on one side only of the paper. Articles thus received will be returned when found unsuitable for the Journal.

Those engaged in Scientific Research are invited to make this Journal the medium of recording their work, and facilities will be extended to those desirous of publishing original communications possessing merit.

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Both questions and answers in "Notes and Queries" should be made as brief as possible; an answer appearing to demand an elaborate reply may be written in the form of an article.

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JOHN MICHELS, Editor.

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SATURDAY, FEBRUARY 19, 1881.

### PROFESSOR WATSON'S SUCCESSOR.

Prof. E. S. Holden, U. S. N., has been detached from the Naval Observatory, and granted a year's leave of absence, in order to take charge of the Washburn Observatory, of the University of Wisconsin.

The sudden death of Prof. Watson left his plans in a very unfinished state. He had partially completed, at his own expense, a "solar observatory" which bears his name. His plan was new, and he intended to re-discover the intramercorial planet, Vulcan, which he reported during the total eclipse of 1878. At the bottom of a hill, sloping at an angle of about forty-five degrees, a small building with a deep cellar was built. A tunnel about eighteen inches in diameter and fifty-five feet long, parallel to the earth's axis, connects this cellar with a pier at the top of the hill which is to support a heliostat. As the tube is pointed directly towards the north pole, it is necessary to give the heliostat but one motion in order to keep the sun in the field of view of the observing telescope placed in the cellar at the bottom of the hill. The object of the long tube was to cut off as much of the stray light as possible, and to enable the observer to examine objects close to the sun's limb.

The Washburn Observatory is provided with an excellent 16-inch Clark equatorial, which is ready for work. Fauth & Co., of Washington, are making a good 3-inch transit instrument, similar to that of the Princeton College Observatory, and it is probable that later a 6-inch meridian circle will be ordered from Repsold, of Hamburg.

The work to be carried on for the coming year consists, mainly, of a systematic review of the heavens, following up Herschel's work. It is probable that this work will be done by Professor Holden and Mr. S. W. Burnham, in concert. The transit instrument will be used by Mr. G. C. Comstock in maintaining a time-

service, and incidentally in obtaining a set of Right Ascensions of the sun, and an extended series of observations of Polaris.

The State of Wisconsin has provided for the printing of the publications of the Observatory. The volumes will be issued at irregular intervals. No. I. will be a History of the Observatory under Prof. Watson's administration, together with the reduction tables prepared by his directions, and No. II. will probably contain Burnham's General Catalogue of Double Stars for 1880.

It is said that during the memorable battle of Waterloo, competent judges pronounced Wellington more than once a defeated general, and that, according to the rules of war, he should have retreated on Brussels. But Napoleon looked in vain from La Belle Alliance to see his foes fleeing before him, for Wellington had given the order "*stand fast, we must not be beaten*," and in a few hours he was marching victoriously on the road to Paris.

During the last twelve months we have heard much of another man, who was supposed to be defeated in every point, and was reported by the English scientific press to have abandoned the battle field at Menlo Park, and to be slowly retiring on California. Professional men and others, who accepted such views on the subject, have from time to time, with a persistence worthy of a better cause, proclaimed aloud that Edison was beaten, and that, in their opinion, his whole system of electrical lighting must end in failure.

But Edison, like Wellington, in the midst of many difficulties, merely closed up his ranks and gave the order "*we must not be beaten!*" The historical parallel may be carried further; Edison may be said to have marched on Paris, and entered the enemy's Capitol, for having accomplished his task at Menlo Park, and perfected his system of electric lighting in all its details with the most perfect success, we now find him installed in sumptuous offices in Fifth avenue, New York city, putting into practical operation the full results of his previous experiments.

A company has been formed which will control and place Edison's system of electrical lighting on the market, but "the Master" will himself superintend all the details of the construction department, until a district has been finally laid out and found to be working satisfactorily. Progress has been made in this direction, and the Edison lamps are being placed in position as fast as they can be produced at Menlo Park, under the direction of Mr. Upton.

Taking a retrospective view of the last eighteen months, one may well pause to ponder over the immense amount of work accomplished by Edison during

that period. Scientific investigations of the most complicated nature have been successfully carried on, the ordinary beaten paths of research of the Chemist, the Engineer and the Electrician have been cast aside, and original methods of exploring the whole domain of science employed with indefatigable perseverance. The very text books and scientific literature on which others have relied, proving unreliable, were rejected, and Nature, at its fountain head, consulted in solving the these problems.

With such methods and indomitable will, and with the constant and valued co-operation of Mr. Charles Batchelor and Mr. Francis R. Upton, the great work has been successfully accomplished.

The arrival of Edison in New York with his corps of skilled electricians and engineers, occurs at an opportune moment. Deaths from suffocation caused by the escape of the ordinary illuminating gas have multiplied of late, and as we now write the bodies of two women who have died from this cause, await burial. During the last few days a building on Broadway suffered from a violent explosion of illuminating gas, making the second within a few weeks. In the first instance many persons were injured, and in the more recent case one hundred persons escaped death only by the force of the explosion taking a fortunate direction. With the acceptance of Edison's system of electric illumination, these dangers to health and life, to which we have been so long exposed, become as things of the past, except where voluntarily encountered, and to this extent Edison may claim to have conferred a benefit to which the whole world will be heir.

We are under obligations to the Marchioness Lanza for a fine translation of a paper by the renowned Professor Rudolph Virchow, of Berlin, entitled "*Organic Healing Power*." This paper, involving many points of general scientific interest, will be produced in our next issue.

Virchow is now in his 61st year, and it is 36 years since he was challenged by Count Von Bismarck to fight a duel, on account of Virchow (who was an advanced liberal) having defeated Bismarck's project to obtain money from the Parliament to create a German navy.

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We are under obligations to the Marchioness Lanza for a fine translation of a paper by the renowned Professor Rudolph Virchow, of Berlin, entitled "*Organic Healing Power*." This paper, involving many points of general scientific interest, will be produced in our next issue.

Virchow is now in his 61st year, and it is 36 years since he was challenged by Count Von Bismarck to fight a duel, on account of Virchow (who was an advanced liberal) having defeated Bismarck's project to obtain money from the Parliament to create a German navy.

#### AMERICAN CHEMICAL SOCIETY.

The February meeting of the American Chemical Society was held on Friday evening, February 11, 1881. The meeting was called to order by Vice-President Leeds, after which the following gentlemen were duly elected members of the society, viz.: Messrs. N. Gerber, James F. Slade, Theodore M. Hopkey, Professor F. N. Venable, and E. K. Dunham. Dr. E. R. Squibb then took the chair and Professor A. R. Leeds read the following papers:

I. Upon the invariable production, not only of ozone and hydrogen peroxide, but also of ammonium nitrate in the ozonation of purified air by moist phosphorous.

II. Upon the action of ozone, oxygen and nascent oxygen upon benzene.

III. On a new class of aromatic sulphurous acids.

Mr. J. H. Stebbins, Jr., followed with some remarks on tetra-azo-compounds, substances to which he has paid particular attention, for it will be recollected that a whole series of the di-azo-colors were originally produced by him.

Professor W. G. Levison then gave the Society the results of some recent experiments by him on polarized light. On the conclusion of this paper, the society was adjourned. M. B.

New York, February 17, 1881.

#### NEW YORK MICROSCOPICAL SOCIETY.

The third annual reception of the New York Microscopical Society was held on February 14th, 1881, at the rooms of the Academy of Sciences. The annual address of the President was delivered by Professor R. Hitchcock, who selected as his subject: "The Relations of Science to Modern Thought," on the conclusion of which the meeting resolved into a *conversazione*, when a variety of interesting but familiar objects were exhibited.

THE annual meeting of the German Chemical Society took place December 22, 1880, on which occasion the following officers were elected for the present year: President, A. Baeyer; Vice-Presidents, A. W. Hofmann, L. v. Barth, F. Hoppe-Seyler, H. Landolt; Secretaries, F. Tieman, A. Pinner; Vice-Secretaries, E. Bauman, Eug. Sell; Treasurer, J. F. Holtze; Librarian, S. Gabriel. M. B.

#### THE SOCIETY OF TELEGRAPH ENGINEERS, (England).

On Wednesday, last week, Prof. G. C. Foster, F. R. S., president, read his inaugural address before the Society of Telegraph Engineers and Electricians, the principal thing dwelt upon being the practical importance of a trustworthy system of electrical measurements. The Society, he said, was not merely a professional one, but was concerned with the scientific principles which underlie the practical operations of electricity. The present practical applications of electricity owed their existence to scientific discoveries made just over 60 years ago. Reference was made to the investigations of Oersted in 1820, and Davy in 1821. Induced electrical currents enabled the electric light to cease to be a scientific marvel and become of practical interest to municipal corporations and limited liability companies. Davy first produced an electric light by the passage of currents from a battery of 2000 cells between carbon points. Oersted, Ampère, and Faraday traced out the fundamental laws of the phenomena of induction. In the ordinary course of scientific discovery, the qualitative aspects of phenomena first attracted attention. Quantitative knowledge followed later by degrees. "Absolute values of constants" could only be given when a phenomenon was sufficiently well known for its laws to be expressed in definite mathematical formulæ, or when methods for the determination of such values could be devised. But when definite results had to be produced as part of a commercial undertaking, that point became of the utmost importance from the very first. Examples were given. During the past 100 years an unknown large number of electrical machines had been made for more or less scientific purposes; but after all that experience it was a question as to who could draw up a specification for an electrical machine which should, with a given number of revolu-

tions, produce a known quantity of electricity, or which would charge a condenser of one microfarad capacity to a given potential. Knowledge as to the power of a galvanic battery was much more definite. Everything in that respect could be stated with exactitude. If knowledge of the practical uses of electrical machines were comparable with that in respect to the galvanic battery, knowledge as to the efficiency of the former would soon be equally definite. The necessity of proper standards based on numerical data was understood in more than one branch of physics; but the present remarks were directed only to electricity, which had in recent years undergone almost a complete transformation. After describing the principles upon which a system of electrical measurement should be founded, the steps taken by Ohm, Weber, Oersted, and others, in arriving at definite laws, were related and tabulated for comparison. Weber's system had been extended by Sir W. Thomson, and the practical applications of electricity in its early days produced the necessity of being able to express results upon a coherent system of standard units. For that purpose the committee of the British Association on electrical standards was appointed, and the B. A. unit resulted. The data upon which that unit was founded had subsequently been verified, and at the present time a redetermination of its accuracy was about to take place. The absence of any standard resistance coils was pointed out, and the suggestion made that it would reflect credit on the Society if it at once set to work with the view of establishing a definite standard resistance, with which instruments used for every-day practical purposes could be occasionally verified and adjusted. A paper on "Some Experiments on Induction with the Telephone," by Mr. A. W. Heaviside, was then read. In the discussion which followed, Prof. Hughes, Mr. Stroh, Prof. Ayrton, and others took part.

#### FURTHER NOTES ON THE BRAIN OF THE IGUANA AND OTHER SAUROPSIDÆ.

BY EDWARD C. SPITZKA, M. D.

I would add to the observations published in No. 7, Vol. I. of Science, relating to the brain of the Iguana, the following:

1st. The ganglionic intumescence upon the inner edge of the cerebral hemisphere, which I supposed to represent the homologue of the molecular basis of the Fascia dentata of Tarini in the mammalia, is more voluminous in the middle of the hemispheric length, than in the posterior third. The homologization of the entire inner wall of the hemisphere with the *Cornu Ammonis* of mammals gains strength from the fact that in the Opossum the *Cornu Ammonis* extends almost along the whole inner hemispheric wall, and is but slightly folded as compared with that of the Rodentia. That the elevation which I supposed to correspond to the *fascia dentata* and *tentacula cinerea*, might be interpreted as one of the thalamic tubercles, which I considered an open question at the time of my writing the first communication, and which I now hold to be disposed of definitely as well as the other supposition.

2nd. There is a molecular accumulation at the base of the cerebral hemisphere, in the common basilar gray, and beneath the elevation of the *corpus striatum*, which may correspond to the lenticular nucleus.

3rd. At and above the level of the emerging third pair of nerves, there is a beautiful nucleus of large multipolar cells, resembling the cells of the auditory nucleus (that is of the large celled division of that nucleus) in contour and in dimensions. This cell group in its situation corresponds to the *nucleus tegmenti* of mammals. I would here note that throughout the animal range, the cells of the *nucleus tegmenti* and the special division of the auditory nucleus referred to seem to keep step in development. This fact would add another link to the chain of evidence

attempted by Meynert, who surmised that an auditory tract passed through the cerebellum to the *brachium conjunctivum*, (and therefore through this cell group) on its way to higher projecting fields.

4th. The so-called *nucleus dentatus* of the cerebellum, which should be termed simply *nucleus cerebelli*, since it is not dentated even in all the mammalia, is clearly present in the cerebellum of the Iguana. It can be found at the junction of the cerebellar peduncles with the main cerebellar mass, and consists of well marked cells of moderate dimensions.

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6th. The fourth pair does not reach the valve of Vieussens in levels lower than those in which the root has its origin, as in the turtle (*Nanemys guttatus*, *Chelydra*) and the mammalia, but distinctly arises in the same level in which it reaches the valvule where it decussates. The nerve itself, however, emerges in levels superior to the latter.

7th. While the cells of the oculomotoriotrochlearis nucleus, and those of part of the auditory origin are of large dimensions, those of the abducens, facial, and motor-trigeminal origin are remarkably small. The reduction in size of the cells is as might be inferred accompanied by a reduction in size of their nuclei. This fact suffices to dispose of the recently advanced claims, that motor cells have larger nuclei than sensory ones. The reduction in size of these motor groups and their presenting such a contrast to the great development of the cells in other motor groups in the Iguana, has to my mind much of the enigmatical. The largest cells in the nervous system of the Iguana, are the multipolar cells of the reticular field, (my *ganglion reticulare* in mammals) those of the auditory origin and *nucleus tegmenti* are of the same or nearly the same dimensions.

8th. The mesencephalic nucleus of the fifth pair is represented as in other reptiles by round cells, sunk in the niche between the two optic lobes; they are not spread out on the contour of the central tubular grey, as in mammals, but concentrated more at the median line. Some of the cells can be identified beneath the inter-optic lobes.

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#### RECENT PROGRESS OF SCIENCE.

REV. SAMUEL FLEMING, LL.D., Ph. D.

The progress of science within our own times has been wonderful. Prof. Helmholtz uses the following language: "The contemplation of the astounding activity in all branches of science may well make us stand aghast at the audacity of man, and exclaim with the chorus in the Antigone: Who can survey the whole field of knowledge? Who can grasp the clues, and then thread the labyrinth?" Every department of science has been vastly extended, and every votary of science stimulated to untiring efforts to survey this field, not only, but to enter the secret chambers of knowledge to find the treasures concealed from the human mind, until modern discoveries, modern analysis, and modern invention have combined to make those hitherto hidden facts of science known, and available for practical benefits to human society.

The exact science, Mathematics, has found ample room for the application of its principles and methods of determining the content of all material existences and relations. The sublime science, Astronomy, has reveled in its excursions into illimitable space, adding new triumphs, discovering new facts pertaining to the constitution of the stellar universe, and the relations of the celestial masses, measuring, by the agency of light, the immense distances, magnitudes and motions of the tiny objects which

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It is not the aim of the writer to pursue the history of the development of the sciences, exhaustively, but to indicate some of the lines of progress.

The brilliant discoveries in Astronomy, within the past few years, have added largely to the wealth of this noble science, fascinating the student, and inspiring to new achievements. Previous to the present century, the solar system included seven primary planets as having at that time been discovered. In the year 1800 a new planet was discovered, and designated an asteroid, or small star,—but it is more properly called a planetoid, or small planet. The name by which this is known is Ceres, after the reputed originator, or god, of corn. It was an event of so great interest to astronomers that it was announced with much éclat that "The long-expected planet between Mars and Jupiter had been discovered." Soon after, three more were observed. Since that time, by means of the greatly increased power of telescopes, more than two hundred have been added by discovery, all being very small. Many others will be found. The problem still to be determined has been, whether these planetoids are "fragments of a broken world," as formerly supposed, or separate condensations from cosmic matter, instead of forming one large body, as in the case of other primary planets. It is not probable, however, that a cosmic mass exploded at any one period, producing such fragments in such positions in their orbits as they maintain, nor that such original mass was so dissipated by the action of a propulsive or radiate force at one time, as to resume its original nebulous state. The second hypothesis is the more probable, viz.: of separate condensations from original nebulosity.

Neptune, one of the largest planets, and nearly twice the distance of Herschel from the sun, was discovered in 1846 by M. Challis, of Paris, and its elements and orbit determined by Le Verrier. The discovery of this planet furnished a satisfactory explanation of the aberrations of the planet Herschel, caused by the approximations of Neptune, though distant, at its nearest point, more than a billion and a half miles. This increase of the number of the solar family furnished an additional illustration, on a grand scale, of the laws of universal gravitation and

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of celestial mechanics. Added to this have been discoveries abundantly confirming the theory of stellar motion in groups, clusters and nebulae, "the places of more than 200,000 stars having already been determined," and we have some conception of the vastness of human achievements, and of the possibilities still awaiting discoveries in this illimitable "field of ether."

The universality and laws of primary force, denominated gravitation, have been subjects of exceeding interest, as they pertain to this primary mode of motion. The fact of an attractive Force acting either upon or within bodies by which they tend to approach each other, arrested the attention, about the year 1600, of the elder Galileo, who extended the principle to all terrestrial bodies, Newton, eighty years afterward, studying this principle, and at the suggestion, it is said, of the fall of an apple, found that there was a definite increase of velocity of bodies approaching the earth, and also that the same kind of attractive force must apply to the moon, while a centrifugal force, either generated from the attractive force, or originated from an extraneous force, continued this secondary planet around the earth. This was the first grand step toward the discovery of the laws of gravitation, applicable to the motion of the earth around the sun, and, generally, to all planets. More recently the principle has been applied to comets, stellar and other masses.

Geology, while below chemistry in the order of nature and classification, had made far less progress in development at the commencement of the present century, a fact which might have been presumed, inasmuch as the latter science has ministered especially to the wants of mankind. According to Buckland, it was at that time "without a name." The general features of geology had been sketched by Leibnitz and Hooke more than a century previous. Near the beginning of the present century the outlines of the subject were classified into three general divisions of formations—the primitive, the secondary and the tertiary. These became the subjects of investigation, historically, in the order named. The first, especially, by Werner, of Germany, who examined chiefly the primitive and transition rocks. The second by Wm. Smith (English), whose observations were first published in 1799. The third by Cuvier and Brougniart whose works upon "Organic Remains" and "Mineral Geography" were published in 1808. During the past half century this science has advanced with other sciences, with vastly increased interest and success, rendering this one of the most fascinating, especially in more recent times, in yielding its stores of facts pertaining to the glacial period, the deposition of metallic substances, experiments showing the order and conditions of the cooling processes, resulting in the different mineral states, and the wonderful revelations of paleontological history, together with many other facts of great interest, but which cannot, in this paper, be especially given. These give abundant confirmation to the theory that immense periods of time, measured by millions of years, have passed during this history, dissipating the doctrine formerly held by many as taught in the Scriptures, that the heavens and earth were created, out of nothing, about six thousand years ago.

Among the departments of science which minister to the wants of human society, none has awakened the spirit of invention and improvement at all to compare with that of Mechanics. With the increase of knowledge, there has been a correspondingly increasing demand for instruments of discovery and analysis, not only, but for the application of scientific skill in the invention of motive powers and the means of the transmission of intelligence, as well as implements of handicraft, of agriculture, etc. The steam power, first utilized by the invention of a machine in 1655, and improved by Watt in 1774, inaugurated its grand work for human society in 1806, when Robert Fulton, after repeated ex-

periments, applied this power to the propulsion of vessels, first on the Hudson river, amazing the thousands who witnessed the successful experiment, and introducing a new propelling power to vessels upon the sea, now bearing their burdens, estimated by millions of tons, on every river and over every lake and sea of earth. This power has added incalculable millions to the material wealth and strength of every civilized nation. The last world-wide application of this power, besides its innumerable minor applications to all kinds of mechanical work, was inaugurated in 1821, when it was successfully applied to the propulsion of railroad trains.

In 1819 Electro-magnetism was first applied to mechanical purposes; and in 1831 the Magnetic Telegraph, for the transmission of intelligence, was invented and successfully applied. And now, even the comparatively coarse medium, air, has aided in business and social communications, at trifling expense, by means of the recently invented Telephone and the Phonograph.

Chemistry has shared richly in the results of recent scientific progress, and has ministered richly to the wants of human society. Three centuries ago, Paracelsus boasted of possessing the "philosopher's stone", by which the baser metals were said to be transmuted into gold; but he gave a new direction to the efforts and objects of Alchemy, insisting that its chief aim should be the preparation of medicines of different kinds for different diseases. But Chemistry, as a science, must date its commencement two centuries later, when the analyses of distinguished scholars, as Scheele, of Sweden, and Dr. Black, of Glasgow University, and the Academies of Science at Berlin and Paris, determined important principles of this science.

The discoveries of Sir Humphrey Davy, in the early part of the present century, gave a new impetus to this branch, leading to chemical analyses and the establishment of chemistry as a science. These have been followed by eras of progress which have brought the subject to a high degree of perfection. Now, the four elements of the ancients, and of the alchemists of comparatively recent times—earth, air, fire, and water—have been found by successive analyses to contain sixty-five elements, the last four having been detected by the new and wonderful method called the Spectrum Analysis. It may be here stated what this method is, for the gratification of any whose attention may not have been called especially to it.

It is well known that a spectrum is an image formed by the light of the sun, or any other luminous body, either as direct or reflected rays, passing through a triangular piece of glass called a prism. The colored lines thus formed by differently refracted and dispersed rays, reveal the nature and qualities of the elements contained in the luminous body by the different colors, combinations, and the phenomena presented, compared with previous results of experiment in the laboratory, upon light reflected from different mineral substances. It has been found that every kind of mineral substance, whether in the form of a solid, gas, or nebulous matter, when in a state of intense luminosity, possesses the capacity to emit a specific color, with its accompanying mixed lines. This being known, when a new body is analysed by its light, its constituents are determined by the lines of light. Thus the solar envelopes, protuberances, etc., of the sun are examined by the analysis of the solar spectrum. By this method, the character of comets, meteors, or other celestial masses are determined. By this the problem of the sudden appearance or disappearance of stellar masses is explained, by determining the state of the mass thus emitting light, and the conditions of luminosity. What the telescope has failed to determine in respect to the elements and qualities of bodies, or the nature of nebulous masses, whether such masses are clusters of stars in the infinite distance, or of original, unformed nebulous matter, the spectroscope has accomplished; and what has been held by most astronomers as a theory, has become

confirmed as a fact, that, as Prof. Schellen says, "luminous nebulae actually exist as isolated bodies in space, and these bodies are masses of gas." Thus, clusters, groups, stars and planets, are in process of genesis from primeval cosmic matter, and Cosmology may be regarded as a science, established by the aid of art in the construction of larger telescopes, and their new associate in the field of stellar research, the spectroscope; these bring within the scope of observation new facts, and confirm the generally received theory of the nebular constitution and the genesis of the stellar and planetary systems from such original cosmic matter.

The conservation of all the lower departments of science to the wants of man, in his individual and social relations, gives a vast superiority of rank to Anthropology. In recent times, the chief points of practical importance in the progress or development of this science have pertained to Sociology. Researches in special lines of investigation have furnished many facts of great interest pertaining to antiquities, archives of ancient cities, inscriptions upon rocks, hieroglyphics and monuments, which have yielded abundant fruits to explorers, and vastly increased the knowledge of particular races and languages; while increasing evidences are furnished that the antiquity of the human race is much greater than that indicated by the generally accepted chronology.

In the department of Philology, great progress has been made during the period of our own times. Comparative Philology is no longer confined to the Latin and Greek of the ancient languages, and two or three of the modern languages, but every language of the globe is yielding rich fruits bearing upon history as well as philology; especially has the Sanscrit, the mother of all the Indo-European languages, received special attention, resulting in the establishment of professorships of the Sanscrit in several colleges.

But questions of the highest interest pertain to Psychology, especially relating to our psychical nature and its connection with our physiological constitution, to the phenomena of "Unconscious cerebration," and other facts which have elicited research in the modes of receiving and retaining sensations and the memory of facts, and in the medium of transmitting such impressions. Such inquiries have led to the adoption of the following theory of accounting for these phenomena, viz.: that the psychical constitution is not simply mental or spiritual, but is *dual* or two-fold, consisting of two substances we may conveniently term respectively *etheral* and *spiritual*. The following rational deductions are given as the only satisfactory hypotheses pertaining to our interior being, viz.: That the great rapidity of the transmission of impressions, being at least 100 feet per second from the extreme parts of our physical system to the brain, or requiring but one-fifteenth of a second to produce a sensation, involves the necessity of the existence of an ethereal substance permeating the nerves, and hence called "nervous ether," which forms the elementary substance of the formal psychical nature. That, as the physical germ is the initial organism of the future physical body, "potentially alive," in the germinal state, so this nervous ether contains the psychical germ or initial organism of the future psychical body, potentially perfected, and which emerges, in its real or developed form, upon the death of the physical body, or properly its separation from the soul, or interior being. That the psychical nature, while connected with the physical, forms the basis of vital action, continuity and identity; and that the mechanism of thought and feeling involves the necessity of two psychical centres of activity, corresponding with the brain and heart, viz.: the psychical *sensorium*, which is the seat of intellectual action, the basis of sensation, memory, etc., and the psychical *cardium*, the seat of the emotional and sympathetic affections.

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special sciences and extended the limits of those previously known. This has created the necessity of the division of scientific research, inducing students to pursue single lines of inquiry, the result being more thorough and extensive knowledge of the respective departments, which have become the common heritage. Examples of this devotion to special sciences are now numerous in every department, as in the case of the late Prof. L. Agassiz, who devoted many years to the study of animalculæ. In the history of plants and animals, species, genera, and even classes have been multiplied, as individuals have devoted their lives to these subjects, with all the helps at command, leaving no depths unexplored. The anatomist and physiologist no longer confine attention to the human structure, but find in comparative anatomy and physiology many types and characteristics brought forward and perfected in the higher orders, or old forms substituted by new, till finally, in the human constitution the completed form best adapted, not to the lower purposes of physical strength and endurance, by which the animal subserves human ends, but the best form for the higher ends of intellectual, moral and social natures by which man is evidently distinguished above the brute.

This division of labor has been found essential in application to the numerous sciences now demanding vastly increased forces of professional teachers in colleges and universities. Now, a college can scarcely claim the name of a liberal institution of learning in which one professor is required to associate sciences so unnaturally connected as Mathematics and Moral Philosophy, or Chemistry, Botany and Pharmacy, as in some European colleges a century ago. A comparison of the courses of study and the professorships in colleges in our country during the past thirty or forty years will exhibit the marked advancement of the sciences, and the increased requirements of the present time. In 1837, Geneva College, now Hobart College, Geneva, N. Y., of which the writer was a student, contained a professorship of "Mathematics and Natural Philosophy;" of the "Latin and Greek languages;" of "Modern languages, History and Belles-Lettres," to which was added Rhetoric and two other mixed professorships. For the year 1849-1850, the catalogue of Western Reserve College, Hudson, O., of which the writer had been a theological student, exhibits the following: The institution embraced three departments: General Science, Medicine, and Theology, besides a preparatory department. Five professors gave instruction in General Science, or the Literary department; one of which was the professor of the "Latin and Greek;" one of "Chemistry, History, Medical Jurisprudence (in the Medical department), and Natural History,"—the latter embracing several branches, including Geology! and one professor of "Modern Languages." Great advancement upon this order is now exhibited in the principle colleges of our land. I here name only three: In 1875, Lafayette College, Easton, Pa., had twenty professors and adjunct professors, besides tutors, assistants and lecturers—twenty-seven in all. The University of Wooster, O., in 1876, had thirteen instructors in the Literary department, and the same number in the Medical department. The Michigan University, Ann Arbor, Mich., in 1877, had, in all departments, fifty-five instructors.

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The consideration of certain facts clearly indicates that the real cause of the blue tints of the waters of certain lakes and seas, is to be traced to the presence of finely-divided matter in a state of suspension in the liquid. We have seen that Sir I. Newton, and most of his successors as late as 1869, ascribed the blue color of certain



deep waters to an inherent selective reflecting property of its molecules, by which they reflected the blue rays of light more copiously than the other rays of the solar spectrum. Since the researches of Soret, Tyndall and others, this selective reflection has been transferred to the finely-divided particles which are known to be held in suspension in greater or less abundance, not only in all natural waters, but even in the most carefully distilled water. When the depth of water is sufficiently great to preclude any solar rays reaching the bottom, then the various shades of blue which are perceived under similar conditions of sunshine, will depend upon the attenuation and abundance of materials held in suspension; the purity and delicacy of the tint increasing with the smallness and the degree of diffusion of the suspended particles. Moreover, it is evident that Tyndall is quite correct in assigning to "true molecular absorption" some agency in augmenting "the intense and exceptional blueness" of certain waters; for it is obvious that the "blue of scattering by small particles" must be purified by the abstraction of the less refrangible rays, which always accompany the blue during the transmission of the scattered light to the observer. It seems to be very certain that were water perfectly free from suspended matter and coloring substances in solution, and of uniform density, it would scatter no light at all. "But," as Tyndall remarks, "an amount of impurity so infinitesimal as to be scarcely expressible in numbers, and the individual particles of which are so small as wholly to elude the microscope," may be revealed in an obvious and striking manner when examined by a powerfully concentrated beam of light in a darkened chamber. If the waters of the lakes and seas were chemically pure and optically homogeneous, absolute extinction of the traversing solar rays would be the consequence if they were deep enough. So that to an observer floating on the surface, such waters would appear as "black as ink," and apart from a slight glimmer of ordinary light reflected from the surface, no light, and hence no color would reach the eye from the body of the liquid. According to Tyndall, "in very clear and very deep sea water, this condition is approximately fulfilled, and hence the extraordinary darkness of such water." In some places, when looked down upon, the water "was of almost inky blackness—black qualified by a trace of indigo." But even this trace of indigo he ascribes to the small amount of suspended matter, which is never absent even in the purest natural water, throwing back to the eye a modicum of light before the traversing rays attain a depth necessary for absolute extinction. He adds: "An effect precisely similar occurs under the moraines of the Swiss glaciers. The ice is here exceptionally compact, and owing to the absence of the internal scattering common in bubbled ice the light plunges into the mass, is extinguished, and the perfectly clear ice presents an appearance of pitchy blackness" ("Hours of Exercise in the Alps;" "Voyage to Algeria to Observe the Eclipse," Am. Ed., N. Y., 1871, pp. 463-470). In like manner the waters of certain Welsh tarns, which are reputed to be bottomless, are said to present an inky hue. And it is more than probable that the waters of the Silver spring, whose exceptional transparency has been previously indicated, would, if they were sufficiently deep, present a similar blackness, or absence of all color by diffuse reflection.

It remains for us to explain the cause of the green tints which the waters of certain lakes and seas assume under peculiar circumstances. These green colors manifest themselves under the following conditions, viz: (a.) In the finest blue water, when the depth is so small as to allow the transmitted light to be reflected from a bottom which is more or less white. Thus, a white sandy bottom or white rocks beneath the surface of the Lake of Geneva, or the Bay of Naples, or of Lake Tahoe, will, if the depth is not too great or too small, impart a beautiful emerald green to the waters above them. (b.) In

the finest blue water, when a white object is looked at through the intervening stratum of water. In the blue waters of the sea this is frequently seen in looking at the white bellies of the porpoises, as they gambol about a ship or steamer. In a rough sea, the light which has traversed the crest of a wave and is reflected back to the eye of the observer from the white foam on the remote side, sometimes crowns it with a beautiful green cap. In March, 1869, I observed this phenomenon in the magnificent ultramarine waters of the Caribbean sea. A stout white dinner plate secured to a sounding line, presents various tints of green as it is let down into the blue water. Such experiments were made by Count Xavier de Maistre, in the Bay of Naples, in 1832; by Prof. Tyndall, in the Atlantic ocean, in December, 1870, and by the writer in Lake Tahoe, in August and September, 1873. (c.) In waters of all degrees of depth when a greater amount of solid matter is held in suspension than is required to produce the blue color of the purer deep waters of lakes and seas. Thus, Tyndall, in his "Voyage to Algeria to observe the Eclipse," in December, 1870, collected 19 bottles of water from various places in the Atlantic ocean between Gibraltar and Spithead. These specimens were taken from the sea at positions where its waters presented tints varying from deep indigo blue, through bright green to yellow green. After his return to England, he directed the concentrated beam from an electric lamp through the several specimens of water and found that the blue waters indicated the presence of a small amount of suspended matter; the bright green a decidedly greater amount of suspended particles, and the yellow green was exceeding thick with suspended corpuscles. He remarks: "My home observations, I think, clearly establish the association of the green color of sea water with fine suspended matter, and the association of the ultramarine color, and more especially of the black indigo hue of sea water, with the comparative absence of such matter." ("Hours of Exercise in the Alps;" "Voyage to Algeria to observe the Eclipse," Ed. cit. ante, pp. 464 et 467.)

There is one feature which is common to all of the three above indicated conditions, under which the green color manifests itself in the waters of the lakes and seas, viz: When a white or more or less light-colored reflecting surface is seen through a stratum of intervening water of sufficient purity and thickness. Condition (c.) is obviously included; for it is evident that a background of suspended particles may, under proper conditions, form such a reflecting surface.

Inasmuch as under these several conditions, more or less of transmitted light is reflected back to the eye of the observer, it is evident that the rays which reach him carry with them the chromatic modifications due to the combined influence of the selective absorption of the water itself, and the selective reflection from the smaller suspended particles. Hence, the chromatic phenomena presented, being produced by the mingling of these rays in various proportions, must manifest complex combinations of tints, under varying circumstances relating to color of bottom, depth of water, and the amount and character of the suspended matter present. In the explanations of the green color of certain waters by the older physicists, we recognize the full appreciation of the influence of selective reflections in the productions of the phenomena; but they seem to have overlooked the important effects of the molecular absorption. We have seen that Sir I. Newton regarded the green tints of seawater as due to the more copious reflection of the violet, blue and green rays, while those constituting the red end of the spectrum are allowed to penetrate to greater depths. ("Optics, loc. cit. ante.") Sir H. Davy ascribes it, in part, to the presence of iodine and bromine in the waters, imparting a yellow tint, which, mingled with the blue color from pure water, produced the sea-green. ("Salmonia, Collected Works," Vol. 9, p. 201.) In like

manner, Count Xavier De Maistre ascribed the green tints to the yellow light, which, penetrating the water and reaching the white bottom or other light-colored submerged objects, and being reflected and mixed with the blue which reaches the eye from all quarters, produces the green. ("Bibl. Univ.," Vol. 51, pp. 259-278, Nov., 1832; also Am. J. Sci., first series, Vol. 26, pp. 65-75, 1834.\*). On the other hand, after Bunsen, in 1847, had established that chemically pure water extinguished the rays of light constituting the red end of the solar spectrum more copiously than those of the blue extremity, so that the transmitted tints were more or less tinged with blue, some chemists were inclined to attribute the green color of certain waters to the presence of foreign coloring substances. Thus Bunsen himself explained the brown colors of many waters, especially of the north-German inland lakes, as produced by an admixture of humus; but he considered the green tints of the Swiss lakes and silicious springs of Iceland as rising from the color of the yellowish bottom. (Vide. loc. cit. ante., p. 44, et seq.) Similarly we find that Wittstein, in 1860, from chemical considerations, concluded that the green color derives its origin from organic admixtures, because the less organic substance a water contains the less does the color differ from blue; and with increase of organic substances the blue gradually passes into green, and ultimately into brown. This is likewise the view taken in 1862, by Beets, for he insists that in all waters the observed color of the liquid is that of the transmitted light, and not, in any case, of the reflected light. Moreover, he maintains that Newton, De Maistre, Arago and others were mistaken in classifying water among those bodies which have a different color by transmitted light to that which they have by reflected light. (Loc. cit. ante.)

We have already shown that if the waters were chemically pure and perfectly free from suspended particles, the red rays of the traversing solar light would be first absorbed and disappear, while the other colored rays pass to greater depths, one after the other being extinguished in their proper order, viz., red, orange, yellow green, blue and violet, until at last there is a complete extinction of the light in the deeper mass of the liquid. But the presence of suspended particles causes a part of the traversing solar light to be reflected, and according as this reflected light has come from various depths, so will the color vary. If, for example, the particles are large, or are abundant and freely reflect from a moderate depth, and prevent reflection from a greater depth, the color will be some shade of green.

When the water is shallow and a more or less light-colored bottom, or a submerged object reflects the transmitted light to the observer through the intervening stratum of liquid, it is evident that the chromatic tints presented must be due to the combined influence of the selective absorption of the water itself, and the selective reflection from the smaller suspended particles.

In other terms, under these conditions, the tints are produced by the mingling of the blue rays with the yellow, orange or red; so that the resulting hues must generally be some shade of green. In short, all the facts established by modern investigations seem to converge and point to the admixture of the blue rays reflected from the smaller suspended particles with the yellow orange and red rays reflected from the grosser matters below, as the true physical cause of the green tints of such waters.

The establishments of the very important function of solid particles held in suspension in water, in producing chromatic modifications both in the scattered light and in the transmitted light, serves to reconcile and to harmonize the

apparent discrepancies and contradictions in the views of physicists who have investigated the color of water.

We have already seen that Sir I. Newton and most of his successors, as late as 1847, regarded water as belonging to the opalescent class of liquids, in which the diffuse reflected light and the transmitted light present more or less complementary tints; the former partaking more of the colors constituting the blue end of the solar spectrum, while the latter presented more of the hues belonging to the red extremity. On the contrary, the more recent and more accurate experiments render it quite certain that in distilled water the rays of the red end of the spectrum are more copiously absorbed than those of the blue extremity; so that the emergent transmitted tint is yellowish green or greenish blue. At first view, these results appear to be discordant and irreconcilable; but, it will be recollected, that while even the most carefully distilled water contains a sufficient amount of suspended matter, to scatter enough light, to render the track of the traversing concentrated solar beam visible, yet, in this case, the selective reflection of the blue rays, due to the suspended particles, is not adequate to neutralize the selective molecular absorption of the rays toward the red end of the spectrum. Nevertheless, as has been previously shown, the addition of very minute quantities of diffused suspended matter confers on distilled water the dichroitic properties of an opalescent liquid.

The presence of an extremely small amount of suspended solid corpuscles, by selectively reflecting the shorter waves of light, is sufficient to neutralize and overcome the selectively absorbent action of the molecules of water on the longer waves; and thus, to impart yellow, orange or red tints to the transmitted beam. Moreover, it is very questionable whether any natural waters are sufficiently free from suspended matter to deprive them of these dichroitic characteristics.

Under this aspect of the subject, the views of Newton, derived from the observations of Halley, those of Hassenfratz deduced from his own experiments, as well as the explanations of the green tints of certain waters given by De Maistre, Arago and others, completely harmonize with the conclusions deducible from modern researches, provided the property of selective reflection is transferred from the aqueous molecules to the finely-divided particles held in suspension.

As a striking illustration of the slight causes which sometimes transform the purest water into an opalescent or dichromatic liquid, it may be interesting to detail one of my own experiences. On the 21st of Dec., 1878, the series of glass tubes employed in my experiments (as previously indicated), being filled with distilled water, the transmitted solar beam presented when received upon a white screen in a darkened room, the usual yellowish-green tint of my winter observations. On the 24th of December, or after an interval of three days, during which all parts of the apparatus had remained *in situ*, I was much surprised to find that the transmitted solar beam was enfeebled, and presented an orange red color with no tinge of green. Puzzled to discover what could have produced so marked a change in the optical properties of the liquid, the "scientific use of the imagination" pictured the possible development of ultra-microscopic germ, infusoria, *bacteria*, *confervæ*, etc. The next day (December 25th), the same phenomenon presented itself, when I called the attention of my assistant, Mr. August Harding, who had kindly prepared the arrangement of the tubes, to the anomalous change that had taken place in the color of the transmitted beam. He suggested that as he had used alcohol in cleaning the glass plates, closing the ends of the tubes, and as the plates were secured to corks by means of Canada balsam, the alcohol absorbed by the corks, being gradually diffused, dissolved some of the balsam, which solution, mingling with the water, might produce a fine resinous precipitate, which might stifle the transmitted beam and

\* Similarly, Arago has very ingeniously applied the same principles to the explanation of the varying colors of the waters of the ocean under different circumstances, showing that when calm it must be blue by the reflective light, but when ruffled the waves acting the part of prisms, refract to the eye some of the transmitted light from the interior, and it then appears green. ("Comptes Rendus," tome vii., p. 219, July 23d, 1838.)



scatter the rays of shorter wave length, thus leaving the orange-red rays predominant in the emergent light. This view was speedily verified by a critical examination of the track of the traversing beam. A sensible turbidity was visible, in the darkened room, at the extremities of the column of water adjacent to the corks securing the glass plates; and the light diffused latterly at these portions, when examined by Nicol's prism, was found to be distinctly polarized. The emergent beam examined by the spectroscope, exhibited orange and red in full intensity; but the yellow and green were greatly diminished. Ten days later (January 2, 1879) the solar beam traversing the same column of water emerged much brighter than on Christmas day, and the tint was orange tinged with yellow and red. This long repose caused, doubtless, some of the resinous precipitate to become more generally diffused, or to subside, and thus diminished the turbidity of the liquid. The recognition of the dichroism imparted to water by the presence of finely-divided particles in suspension, serves, likewise, to harmonize the conflicting views promulgated by physicists who have studied the chromatic phenomena presented by this liquid. Some claim that the rays of higher refrangibility are more copiously withdrawn by absorption; while others maintain that the rays of longer wave lengths are more absorbed. In many cases the chromatic tints ascribed to selective molecular absorption are unquestionably due to selective diffuse reflection from the ultra-microscopical corpuscles which are held in suspension. (*Vide Jamin's "Cours de Physique,"* 3d ed., tome 3, p. 447, *et seq.*)

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"The study of insects assumes an importance in this country far greater than in any other part of the world. No where else does mother earth yield in such variety and in such abundance her agricultural products; after supplying to repletion our own people, the excess is distributed to every quarter of the globe. Few, surprisingly few, of these varied products are native to our soil. Nearly all of our fruits, grasses, cereals and vegetables, and perhaps three-fourths of our weeds are of foreign importation—mainly from Europe. With their introduction, very many of the insects that preyed upon them were also introduced, or have been subsequently brought hither. But unfortunately for us, the parasites which preyed upon them and kept them under control, have for the most part, been left behind. As the result, the imported pests, in their new home, find their favorite food-plants spread out in luxuriant growth over broad acres, where they may ply their destructive work without

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COLORADO SPRINGS, *January 29, 1881.*

# NOTE ON DR. HENRY DRAPER'S PHOTOGRAPH OF THE NEBULA IN ORION.\*

BY MR. RANYARD.

\*Read before the Royal Astronomical Society, Jan. 14, 1881.

Dr. Draper has sent me an enlarged copy of a photograph of the nebula in Orion, which he succeeded in taking on the night of the 30th of September last. Dr. Draper remarks that September is not the best time of the year, so that he hopes to obtain still better results next summer. The photograph was taken with an exposure of 51 minutes. He does not mention the instrument with which it was taken, but I conclude that it was with his great 27-inch reflector. On the photograph are nine white spots of various sizes; these represent 13 stars in and about the nebula, for the four stars of the trapezium are merged together by reason of over-exposure. In the corner is another small photograph taken with a shorter exposure, and showing three of the four stars of the trapezium. This is not the first occasion on which the stars of the trapezium have been photographed. I, and no doubt many others, have succeeded in obtaining photographs of them. But it is, I believe, the first photograph in which any trace of the nebula is shown. And Dr. Draper may, I think, be very much congratulated on the great success he has attained. The photograph shows the whole of the brighter nucleus of the nebula—sometimes referred to as the "Fish's head." I have compared it with the different drawings of the nebula by Bond, Herschel, Liapounov, Lassell, Secchi, the Earl of Rosse, and Tempel, and find that it does not correspond exactly with any of them. The drawings differ very greatly amongst themselves, and they differ in type as well as in minor details. They do not appear to differ continuously in order of time, so that the drawings do not afford any proof that the form of the nebula is changing. Photographs will of course afford much more valuable evidence with respect to any such change in the future. The photograph does not show any stars of less than the  $9\frac{1}{2}$  magnitude, showing that the brighter masses of the nebula registered themselves on the plate when stars of the 10th magnitude left no trace. If in the future some much more sensitive method of photographing is devised, it will be necessary to contrive some plan by which the brighter parts of the nebula and the light of the brighter stars may be cut off from the sensitive plate during the greater part of the exposure, so as to prevent the irradiation from the brighter parts encroaching over the area occupied by the fainter parts. At present, however, we are very far from being able to photograph, with the sensitive silver compounds\* made use of, all that can be seen with the human eye. But even if photography does not make any further advances, photographs such as these will be of very great value in showing the relative brightness of the brighter parts of the nebula.

Mr. Common: I do not agree with Mr. Ranyard, that we must look to photography to explain or prove any

change in the form of the nebulae, because various kinds of plates give different results, and you would not have the same effects produced by the same colored light. I should rely much more on accurate drawings than upon any photographs. If we compare these drawings, here you have [pointing to Father Secchi's drawing] a dark mass with a slope of light running from the left-hand corner down to the right hand. In the other [Lord Rosse's drawing] there is no division, except a large space divided into channels. The latter is wrong and the former clearly right. Before you give details you ought to represent the chief features of the nebula, because it is the features that most readily indicate change. With regard to Mr. Ranyard's remark that no star smaller than the 10th magnitude is shown, there are, I think, two—these fainter stars under the trapezium, which are certainly less than the 10th magnitude.

Mr. Ranyard: I have here the magnitudes given by Liapounov, and he gives one as the 9th magnitude and the other as the 9th to the 10th magnitude.

Mr. Common: Before we can discuss this photograph we want to know the instrument it is taken with, the focal length, in order to know the size of the image, and the kind of plates used, and the mode of development. If you want to detect any change in the form of the nebulae you must entirely rely on the hand drawings.

Mr. Ranyard: I think that some considerable scientific use may be made of these photographs; they will at least enable us to compare the relative brightness of the different masses of the nebula as shown on any one photograph, for as far as we know, there is no great difference in the spectrum of different parts of the nebula, and so we have no reason to suppose that the photographic effects of different parts of the nebula in any one photograph would not be proportional to the light.

Mr. Stone: With regard to discrepancies in drawings, I never knew two persons asked to make a drawing of the same faint object make them exactly alike. It is evident that observers draw that which happens to arrest their attention, and one feature will strike one observer, while the attention of another is attracted by something else. A very good instance of this occurred during the eclipse of 1874. Two observers were sitting side by side drawing the corona. The one drew a small nearly quadrilateral corona, while the other drew a large corona with great rays in the equatorial regions. Before a totality was over the observer who had drawn the small corona looked at his neighbor's drawing, and, on looking up again at the corona, recognized the outline which his neighbor had drawn, and commenced to put it on paper when the eclipse ended. There is therefore a great element of uncertainty about drawings, one observer overlooks one part, or is struck by one part, and another by something else.

Mr. Rand Capron: I think that Mr. Common is right, that photographs of objects taken with different instruments and plates will probably never usefully bear comparison; but I agree with Mr. Ranyard that photographs of the same object taken from time to time with the same instrument and the same plates can most usefully be compared.

Mr. Burton said: I should like to suggest that the difficulty which Mr. Ranyard has referred to, with regard to the irradiation from stars interfering with the fainter parts of the nebula, might be got over by placing a prism of small angle, made of quartz or Iceland spar, between the object-glass and the photographic plate. The images of the stars would be drawn out into lines, while there would be three or four images of the nebula which would not interfere. The principal plane of the prism might then be turned round into a different position-angle, and another photograph taken, so that the spectra of the stars would fall in another direction.

Mr. De La Rue said: I recollect very well the time when the Earl of Rosse's drawing was made. I compared

\*[Note by Mr. Ranyard.] It seems probable that the small pencil of light, which passes through the pupil of the eye from the faintest object perceived, produces an actual change in the matter of the rods and cones, which is rapidly obliterated by the circulation and vital processes going on about the retina. This is now, I believe, pretty generally agreed to by physiologists. If in the future the matter acted upon in the rods and cones can be isolated, and the change produced by light can be rendered permanent, it seems probable that, by means of large lenses and reflectors, we may some day obtain photographs of objects too faint to be visible with the naked eye.

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change in the form of the nebulae, because various kinds of plates give different results, and you would not have the same effects produced by the same colored light. I should rely much more on accurate drawings than upon any photographs. If we compare these drawings, here you have [pointing to Father Secchi's drawing] a dark mass with a slope of light running from the left-hand corner down to the right hand. In the other [Lord Rosse's drawing] there is no division, except a large space divided into channels. The latter is wrong and the former clearly right. Before you give details you ought to represent the chief features of the nebula, because it is the features that most readily indicate change. With regard to Mr. Ranyard's remark that no star smaller than the 10th magnitude is shown, there are, I think, two—these fainter stars under the trapezium, which are certainly less than the 10th magnitude.

Mr. Ranyard: I have here the magnitudes given by Liapounov, and he gives one as the 9th magnitude and the other as the 9th to the 10th magnitude.

Mr. Common: Before we can discuss this photograph we want to know the instrument it is taken with, the focal length, in order to know the size of the image, and the kind of plates used, and the mode of development. If you want to detect any change in the form of the nebulae you must entirely rely on the hand drawings.

Mr. Ranyard: I think that some considerable scientific use may be made of these photographs; they will at least enable us to compare the relative brightness of the different masses of the nebula as shown on any one photograph, for as far as we know, there is no great difference in the spectrum of different parts of the nebula, and so we have no reason to suppose that the photographic effects of different parts of the nebula in any one photograph would not be proportional to the light.

Mr. Stone: With regard to discrepancies in drawings, I never knew two persons asked to make a drawing of the same faint object make them exactly alike. It is evident that observers draw that which happens to arrest their attention, and one feature will strike one observer, while the attention of another is attracted by something else. A very good instance of this occurred during the eclipse of 1874. Two observers were sitting side by side drawing the corona. The one drew a small nearly quadrilateral corona, while the other drew a large corona with great rays in the equatorial regions. Before a totality was over the observer who had drawn the small corona looked at his neighbor's drawing, and, on looking up again at the corona, recognized the outline which his neighbor had drawn, and commenced to put it on paper when the eclipse ended. There is therefore a great element of uncertainty about drawings, one observer overlooks one part, or is struck by one part, and another by something else.

Mr. Rand Capron: I think that Mr. Common is right, that photographs of objects taken with different instruments and plates will probably never usefully bear comparison; but I agree with Mr. Ranyard that photographs of the same object taken from time to time with the same instrument and the same plates can most usefully be compared.

Mr. Burton said: I should like to suggest that the difficulty which Mr. Ranyard has referred to, with regard to the irradiation from stars interfering with the fainter parts of the nebula, might be got over by placing a prism of small angle, made of quartz or Iceland spar, between the object-glass and the photographic plate. The images of the stars would be drawn out into lines, while there would be three or four images of the nebula which would not interfere. The principal plane of the prism might then be turned round into a different position-angle, and another photograph taken, so that the spectra of the stars would fall in another direction.

Mr. De La Rue said: I recollect very well the time when the Earl of Rosse's drawing was made. I compared

\*[Note by Mr. Ranyard.] It seems probable that the small pencil of light, which passes through the pupil of the eye from the faintest object perceived, produces an actual change in the matter of the rods and cones, which is rapidly obliterated by the circulation and vital processes going on about the retina. This is now, I believe, pretty generally agreed to by physiologists. If in the future the matter acted upon in the rods and cones can be isolated, and the change produced by light can be rendered permanent, it seems probable that, by means of large lenses and reflectors, we may some day obtain photographs of objects too faint to be visible with the naked eye.

it with the nebula with very great interest at the time, and I cannot agree with Mr. Common in preferring Father Secchi's drawing. It seems to me that the Earl of Rosse's drawing is much the more accurate in respect of details. As regards contour and outline, that depends very much upon the amount of light, which impresses one man's eye rather than another's so that the general outline may be extended much more in one case than in another. Lord Rosse's drawing does not give the whole sweep of the nebula, and does not take in so extensive a field as Father Secchi's drawing. Lord Rosse's drawing is better seen in the black upon white print than in the white upon the black ground.

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Mr. Ranyard said although the actual brightness of various parts of an object like a nebula or corona cannot be judged of from the opacity of corresponding parts of photographs, yet a photograph will enable one to tell with great certainty which is the brightest region of the object photographed, and it affords a very valuable permanent photometric scale, by which various degrees of brightness of one region relatively to another may be judged of. For example, Dr. Draper's photograph shows that a nebulous mass on the preceding side of the trapezium is the brightest region of the nebula. This does not correspond with any of the drawings. It is of course possible that the actinic light of the nebula does not correspond with its luminosity as observed by the eye, but this supposition is not very probable, as the spectroscopic does not show any striking differences in the composition of the light of the nebula. The photograph enables us to judge very well of the relative magnitudes of the stars involved in the nebula. I have compared the magnitudes of the images of the stars in the photograph as enlarged by irradiation, with the magnitudes of the same stars as given by Liapounov, and I find that they correspond very accurately. No doubt it may also be assumed that the brightness of various regions of the nebula may be compared with equal safety by noting the opacity of corresponding parts of the photographic film. With regard to Father Secchi's drawing and the drawing of the Earl of Rosse, I agree with Mr. De La Rue that I rather prefer the Earl of Rosse's. It shows a much smaller region of the nebula, and I must remark that I have not much faith in the existence of these outlying nebulous structures shown in Secchi's and Tempel's drawings. If such structures exist the nebula would occupy an area of more than a degree, and it ought to be seen with the naked eye better than with any telescope. Every one is familiar with the way in which a faint structure like the tail of a comet—which can be easily seen with the naked eye—is lost when viewed with the best of telescopes. A telescope of whatever aperture will not increase the brightness of an object occupying a sensible area.

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Mr. Mitchell: If you get a definite chemical compound with which you make your photographic plate,

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The attempt, however, to compose a text book in Astronomy which should be equally applicable to the class of a college, and to the general reader, was a task which presented few elements of success; we are not therefore surprised to find that the authors candidly state in their preface that in spite of the title selected for the book that the work was principally designed for the use of those who desire to pursue the study of Astronomy as a branch of liberal education.

Regarded in this light the work is a great success, for the general reader will find by a careful perusal of this manual that he has mastered all the leading points in the study of Astronomy in sufficient detail, to enable him in the future to fully comprehend whatever he may read on this subject. The work in question may well serve as a model for those desirous of writing scientific manuals; in simple, but forcible language, the most complicated explanations are presented in a form that may be comprehended by a reader of ordinary intelligence without mental effort, while the interest of the student is maintained throughout.

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We have the authority of Mr. Heller, of the *National Union*, that there was a great cry at first, but advanced education would increase the crime of the land. Of course the contrary has been the real result, and it is stated that there is manifestly less coarseness of manners among the lower classes.

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## LETTERS TO THE EDITOR.

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## DR. FLEMING'S CLASSIFICATION OF SCIENCE.

*To the Editor of SCIENCE:*

There are numberless ways in which knowledge may be classified, as the numerous systems of classification put forward show, and it appears to be a very common notion that all knowledge may be put in a serial order showing the elements in logical dependence. However this may be in metaphysical matters, it is certainly not possible to do so in physical philosophy, for the various manifestations of energy are mutually co-related, and starting with any one of them it is possible to develop almost any of the other forms. In the scheme of Dr. Fleming this does not appear, but in the plan of it he places the doctrine of the correlation of forces high up in Physico Dynamic Science instead of making it almost the first division of Physics. The latter as now understood is the science of energy, and energy always involves two factors, one a mass and the other a velocity. When motions are considered in their geometrical relations, apart from mass, the science is known as Kinematics and as a branch of pure mathematics, it has nothing more to do with physics proper than has geometry, though all problems in physics are more or less mathematical problems, but they become *Dynamic* when mass is involved. Inasmuch as masses of all dimensions, from an atom to the sun, follow the same laws, it surely is not a scientific proceeding to make a grand division here of Astronomy as distinct from the more general division of Mechanics. Astronomy so far as pertains to the genesis of the Stellar Universe is only a development or application of mechanics to large masses of matter. Again the author is mistaken when he says, "Then Natural Philosophy monopolizes the whole field. Now Chemical Philosophy has taken the rank of a distinct department." The fact is that since the discovery that chemism is dependent upon mass, the science has been swallowed up entirely in physics, and every so-called chemical problem is a pure physical problem. Chemism is one of the correlated forms of energy and the logical importance is the same as that of heat and electricity.

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There are numberless ways in which knowledge may be classified, as the numerous systems of classification put forward show, and it appears to be a very common notion that all knowledge may be put in a serial order showing the elements in logical dependence. However this may be in metaphysical matters, it is certainly not possible to do so in physical philosophy, for the various manifestations of energy are mutually co-related, and starting with any one of them it is possible to develop almost any of the other forms. In the scheme of Dr. Fleming this does not appear, but in the plan of it he places the doctrine of the correlation of forces high up in Physico Dynamic Science instead of making it almost the first division of Physics. The latter as now understood is the science of energy, and energy always involves two factors, one a mass and the other a velocity. When motions are considered in their geometrical relations, apart from mass, the science is known as Kinematics and as a branch of pure mathematics, it has nothing more to do with physics proper than has geometry, though all problems in physics are more or less mathematical problems, but they become *Dynamic* when mass is involved. Inasmuch as masses of all dimensions, from an atom to the sun, follow the same laws, it surely is not a scientific proceeding to make a grand division here of Astronomy as distinct from the more general division of Mechanics. Astronomy so far as pertains to the genesis of the Stellar Universe is only a development or application of mechanics to large masses of matter. Again the author is mistaken when he says, "Then Natural Philosophy monopolizes the whole field. Now Chemical Philosophy has taken the rank of a distinct department." The fact is that since the discovery that chemism is dependent upon mass, the science has been swallowed up entirely in physics, and every so-called chemical problem is a pure physical problem. Chemism is one of the correlated forms of energy and the logical importance is the same as that of heat and electricity.

B. D.

## BOOKS RECEIVED.

## ASTRONOMY FOR STUDENTS AND GENERAL READERS.

By SIMON NEWCOMB, L. L. D., and EDWARD S. HOLDEN, M. A. Second Edition, Revised. Henry Holt and Company. New York, 1880. \$2.50.

It may be supposed that the joint efforts of Dr. Simon Newcomb and Professor Edward S. Holden to write a work on Astronomy has resulted in the production of a work which may be accepted by the public as a reliable and able exposition of the subject.

The attempt, however, to compose a text book in Astronomy which should be equally applicable to the class of a college, and to the general reader, was a task which presented few elements of success; we are not therefore surprised to find that the authors candidly state in their preface that in spite of the title selected for the book that the work was principally designed for the use of those who desire to pursue the study of Astronomy as a branch of liberal education.

Regarded in this light the work is a great success, for the general reader will find by a careful perusal of this manual that he has mastered all the leading points in the study of Astronomy in sufficient detail, to enable him in the future to fully comprehend whatever he may read on this subject. The work in question may well serve as a model for those desirous of writing scientific manuals; in simple, but forcible language, the most complicated explanations are presented in a form that may be comprehended by a reader of ordinary intelligence without mental effort, while the interest of the student is maintained throughout.

The description of astronomical instruments and their uses forms a valuable portion of the work, and all the details of observatory work are explained by the aid of good illustrations; thus all the methods by which astronomical research is carried on at the present day are described by one who was himself at that time a member of the corps having in charge one of the most completely equipped observatories that has yet been organized.

The three branches, into which Astronomy is now divided, are all ably treated by the authors, and it is not difficult to detect the plan adopted by the authors in dividing their work.

We regret this manual was not considered worthy of a good index, for on this account the book is valueless as a work of reference. In future editions it would be well to remedy this unnecessary defect.

CIRCULARS OF INFORMATION OF THE BUREAU OF EDUCATION. NO. 4, 1880. Rural School Architecture, with illustrations.

NO. 5. English Rural Schools. Washington, Government Printing Office, 1880.

The first paper (No. 4) presents a concise yet complete treatise on the proper construction, heating and ventilation of school buildings, prepared by Mr. S. M. Clark, a well-known architect of Boston. The aim of the paper is not so much to lay down rules to be inconsiderately followed, as to give principles and directions suggestive of the plans best to be followed under a variety of circumstances.

This is a thoroughly practical paper, and the whole subject has been well handled by Mr. Clark, and the pamphlet cannot fail to be most useful to School Boards and Committees. The Commissioner of the Bureau of Education deserves the thanks of all heads of families for ordering the production of this timely publication, which, however, merely applies to rural districts, and we trust the manual treating on buildings for high schools, academies and colleges will be published without delay,

as it is a matter of common notoriety that the health of children in many of the large cities, is sacrificed in consequence of the school-rooms being constructed without regard to hygienic principles.

No. 5—Is a description of the condition of rural schools and the progress of elementary education in the rural districts of England, written by Mr. Henry W. Hulbert, late of Middleberry College, based on his personal information. He does not attempt to enforce lessons from his facts, but leaves these to the reflection of the reader.

The facts presented by Mr. Hulbert are most interesting, and would appear to indicate that the effort to educate the masses of the people is making slow but steady progress against the opposition raised against it by certain classes.

We have the authority of Mr. Heller, of the *National Union*, that there was a great cry at first, but advanced education would increase the crime of the land. Of course the contrary has been the real result, and it is stated that there is manifestly less coarseness of manners among the lower classes.

It is admitted, however, that a certain restlessness has been created by advanced education, and "that it has driven children into towns to seek what they consider higher situations, and in some cases it has led to emigration."

## LETTERS TO THE EDITOR.

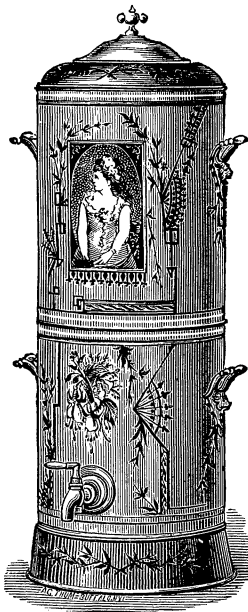
[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

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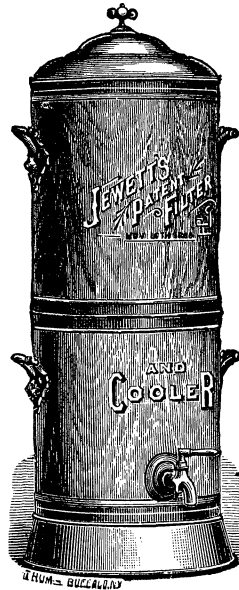
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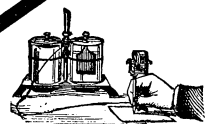
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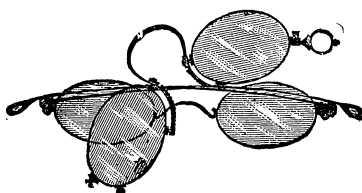
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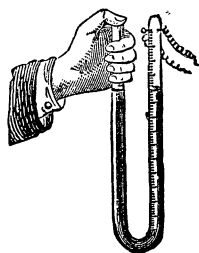
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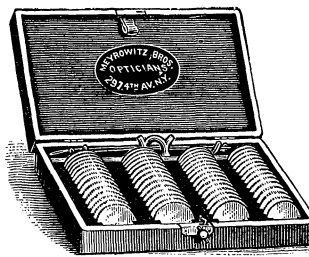


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Vol. II. No. 33, - - - - - February 19, 1881.

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